

# Claims

- [c1] 1. A drive mechanism for a door operator for selectively automatically operating a door positioned within a door frame and hinged along one edge to the door frame for movement between a closed position and an open position, the door operator including a bi-directional motor assembly connected to a source of electrical energy, and a door closer assembly including a rotating output member operably connected to the door and means for providing a force on the output member when the door is in an open position for moving the door in a closing direction, the drive mechanism comprising:  
a drive member including a protrusion formed on the surface of the drive member, one edge of the protrusion forming a first driving surface and the other edge of the protrusion forming a second driving surface, the driving surfaces defining a free space of at least about 90° between the driving surfaces, the drive member adapted to be operably connected to the motor assembly for rotating the drive member about an axis through an arc in a first direction from a first angular orientation corresponding to the closed position of the door to a second angular orientation corresponding to the open position

of the door and about the axis through an arc in an opposite direction from the second angular orientation to the first angular orientation, wherein rotation of the drive member from the first angular orientation to the second angular orientation corresponds to movement of the door from the closed position to the open position; and

a driven member including a protrusion formed on the surface of the driven member, one side of the protrusion forming a first driven surface and the other side of the protrusion forming a second driven surface, the driven member disposed for relative rotation adjacent to the drive member such that the respective protrusions rotate in substantially the same plane and the driven member protrusion moves in the free space defined by the driving surfaces of the drive member protrusion, the driven member adapted to be operably connected for rotation with the output member of the door closer assembly about an axis through an arc between a first angular orientation corresponding to the closed position of the door and a second angular orientation corresponding to the open position of the door and about the axis through an arc in an opposite direction from the second angular orientation to the first angular orientation, wherein rotation of the driven member from the second angular orientation to the first angular orientation corresponds to

movement of the door from the open position to the closed position, wherein when the drive member and the driven member are in their respective first angular orientations, one of the driving surfaces of the protrusion of the drive member is adjacent one of the driven surfaces of the protrusion of the driven member such that rotation of the drive member from the first angular orientation of the drive member to the second angular orientation of the drive member in a direction toward the adjacent driven surface causes rotation of the driven member for powered opening of the door from the closed position to the open position, and the protrusion on the driven member moves in the free space between the first angular orientation of the driven member and the second angular orientation of the driven member without engaging the protrusion surfaces when the door is opened manually from the closed position and allowed to close.

[c2] 2. A drive mechanism as recited in claim 1, wherein the protrusions extend from the surfaces of the drive member and the driven member in a direction substantially parallel to the axis of rotation of the drive member and the driven member.

[c3] 3. A drive mechanism as recited in claim 1, wherein the drive member has an opening for rotatably receiving at

least a portion of the driven member.

- [c4] 4. A drive mechanism as recited in claim 3, wherein the protrusion on the drive member extends from the surface of the drive member in a direction substantially parallel to the axis of rotation of the drive member, and the protrusion on the driven member extends radially outwardly from the surface of the driven member.
- [c5] 5. A drive mechanism as recited in claim 3, wherein the opening in the drive member extends through the drive member, and the ends of the drive member are adapted to be operably connected for rotation with the output member of the door closer assembly.
- [c6] 6. A drive mechanism as recited in claim 5, wherein the protrusion on the drive member extends radially outwardly from one end of the driven member.
- [c7] 7. A drive mechanism as recited in claim 1, wherein the driven member has an opening for rotatably receiving at least a portion of the driven member.
- [c8] 8. A drive mechanism as recited in claim 7, wherein the protrusion on the driven member extends from the surface of the driven member in a direction substantially parallel to the axis of rotation of the driven member, and the protrusion on the drive member extends radially

outwardly from the surface of the drive member.

[c9] 9. An apparatus for use with a source of electrical energy for selectively automatically operating a door positioned within a door frame and hinged along one edge to the door frame for movement between a closed position and an open position, the door operating apparatus comprising:

a bi-directional motor assembly adapted to be connected to the source of electrical energy;

an automatic door closer assembly including a rotatable output shaft adapted to be operably connected to the door and means for providing a force on the output shaft when the door is in an open position for moving the door in a closing direction;

a drive member including a protrusion formed on the surface of the drive member, one edge of the protrusion forming a first driving surface and the other edge of the protrusion forming a second driving surface, the driving surfaces defining a free space of at least about 90° between the driving surfaces, the drive member operably connected to the motor assembly for rotating the drive member about an axis through an arc in a first direction from a first angular orientation corresponding to the closed position of the door to a second angular orientation corresponding to the open position of the door and

about the axis through an arc in an opposite direction from the second angular orientation to the first angular orientation, wherein rotation of the drive member from the first angular orientation to the second angular orientation corresponds to movement of the door from the closed position to the open position; and

a driven member including a protrusion formed on the surface of the driven member, one side of the protrusion forming a first driven surface and the other side of the protrusion forming a second driven surface, the driven member disposed for relative rotation adjacent to the drive member such that the respective protrusions rotate in substantially the same plane and the driven member protrusion moves in the free space defined by the driving surfaces of the drive member protrusion, the driven member adapted to be connected for rotation with the output shaft of the door closer assembly about an axis through an arc between a first angular orientation corresponding to the closed position of the door and a second angular orientation corresponding to the open position of the door and about the axis through an arc in an opposite direction from the second angular orientation to the first angular orientation, wherein rotation of the driven member from the second angular orientation to the first angular orientation corresponds to movement of the door from an open position to the closed position,

wherein when the drive member and the driven member are in their respective first angular orientations, one of the driving surfaces of the protrusion of the drive member is adjacent one of the driven surfaces of the protrusion of the driven member such that rotation of the drive member from the first angular orientation of the drive member to the second angular orientation of the drive member in a direction toward the adjacent driven surface causes rotation of the driven member for powered opening of the door from the closed position to the open position, and the protrusion on the driven member moves in the free space between the first angular orientation of the driven member and the second angular orientation of the driven member without engaging the protrusion surfaces when the door is opened manually from the closed position and allowed to close.

[c10] 10. A door operating apparatus as recited in claim 9, wherein the protrusions extend from the surfaces of the drive member and the driven member in a direction substantially parallel to the axis of rotation of the drive member and the driven member.

[c11] 11. A door operating apparatus as recited in claim 9, wherein the drive member has an opening for rotatably receiving at least a portion of the driven member.

- [c12] 12. A door operating apparatus as recited in claim 11, wherein the protrusion on the drive member extends from the surface of the drive member in a direction substantially parallel to the axis of rotation of the drive member, and the protrusion on the driven member extends radially outwardly from the surface of the driven member.
- [c13] 13. A door operating apparatus as recited in claim 11, wherein the opening in the drive member extends through the drive member, and the ends of the drive member are adapted to be operably connected for rotation with the output member of the door closer assembly.
- [c14] 14. A door operating apparatus as recited in claim 13, wherein the protrusion on the drive member extends radially outwardly from one end of the driven member.
- [c15] 15. A door operating apparatus as recited in claim 9, wherein the driven member has an opening for rotatably receiving at least a portion of the driven member.
- [c16] 16. A door operating apparatus as recited in claim 15, wherein the protrusion on the driven member extends from the surface of the driven member in a direction substantially parallel to the axis of rotation of the driven



member, and the protrusion on the drive member extends radially outwardly from the surface of the drive member.

- [c17] 17. A door operating apparatus as recited in claim 9, further comprising means for actuating the motor, the actuating means including an input device in electrical communication with the motor and activated by a user for selectively directing power to the motor for initiating powered movement of the door from the closed position to an open position.
- [c18] 18. A door operating apparatus as recited in claim 17, wherein the actuating means comprises a controller connected between the input device and the motor and responsive to input signals from the input device for selectively controlling the operation of the motor for moving the drive member between the first and second angular orientations of the drive member.
- [c19] 19. A door operating apparatus as recited in claim 18, further comprising  
a first annular sensor and a second annular sensor ring, each of the sensor rings carrying a switch actuating element, the sensor rings disposed for relative rotation on a shaft that rotates with door movement such that the switch actuating elements rotate in substantially the

same plane, wherein sensor rings and shaft may be non-rotatably secured together at selected angular positions based on predetermined door positions; and  
a switch responsive to the switch actuating elements for transmitting a signal to the controller, the input signal being indicative of the selected angular position of the rings,  
wherein the controller is responsive to the signal for terminating power to the motor, stalling the motor, or reversing the motor direction.

[c20] 20. A door operating apparatus as recited in claim 19, wherein the shaft rotating with door movement comprises rotatable output shaft on the motor.

[c21] 21. A door operating apparatus as recited in claim 18, further comprising means for detecting excessive current drawn by the motor, the controller responsive to the excessive current detecting means for terminating power to the motor.

[c22] 22. A door operating apparatus as recited in claim 18, wherein the controller is remote from the door.

[c23] 23. In combination:  
a door frame for mounting to a building wall;  
a door pivotally connected to the door frame for move-

ment between a closed position and an open position;  
and  
an electro-mechanical door operator mounted on one of  
the door or the building wall, the door operator comprising:  
a bi-directional motor assembly adapted to be connected to a source of electrical energy,  
an automatic door closer assembly adapted to be operably connected to the door, the door closer assembly including a rotatable output shaft and means for providing a force on the output shaft when the door is in an open position for moving the door in a closing direction,  
a drive member including a protrusion formed on the surface of the drive member, one edge of the protrusion forming a first driving surface and the other edge of the protrusion forming a second driving surface, the driving surfaces defining a free space of at least about 90° between the driving surfaces, the drive member operably connected to the motor assembly for rotating the drive member about an axis through an arc in a first direction from a first angular orientation corresponding to the closed position of the door to a second angular orientation corresponding to the open position of the door and about the axis through an arc in an opposite direction from the second angular orientation to the first angular orientation, wherein rotation of the drive member from

the first angular orientation to the second angular orientation corresponds to movement of the door from the closed position to the open position, and a driven member including a protrusion formed on the surface of the driven member, one side of the protrusion forming a first driven surface and the other side of the protrusion forming a second driven surface, the driven member disposed for relative rotation adjacent to the drive member such that the respective protrusions rotate in substantially the same plane and the driven member protrusion moves in the free space defined by the driving surfaces of the drive member protrusion, the driven member adapted to be connected for rotation with the output shaft of the door closer assembly about an axis through an arc between a first angular orientation corresponding to the closed position of the door and a second angular orientation corresponding to the open position of the door and about the axis through an arc in an opposite direction from the second angular orientation to the first angular orientation, wherein rotation of the driven member from the second angular orientation to the first angular orientation corresponds to movement of the door from an open position to the closed position, wherein when the drive member and the driven member are in their respective first angular orientations, one of the driving surfaces of the protrusion of the drive mem-

ber is adjacent to one of the driven surfaces of the protrusion of the driven member such that rotation of the drive member from the first angular orientation of the drive member to the second angular orientation in a direction toward the adjacent driven surface causes rotation of the driven member for powered opening of the door from the closed position to the open position, and the protrusion on the driven member moves in the free space between the first angular orientation of the driven member and the second angular orientation of the driven member without engaging the protrusion surfaces when the door is opened manually from the closed position and allowed to close.

- [c24] 24. A method using a door operator for selectively automatically operating a door positioned within a door frame and hinged along one edge to the door frame for movement between a closed position and an open position, the door operator including a bi-directional motor assembly coupled to a source of electrical energy and an automatic door closer assembly operably connected to the door, the door closer assembly including means for providing a force on the door in a closing direction when the door is in an open position for moving the door to the closed position, the door operating method comprising:

providing a drive mechanism adapted to be disposed between the motor assembly and the door closer assembly, the drive mechanism comprising:

a drive member including a protrusion formed on the surface of the drive member, one edge of the protrusion forming a first driving surface and the other edge of the protrusion forming a second driving surface, the driving surfaces defining a free space between the driving surfaces, the drive member adapted to be operably connected to the motor assembly for rotating the drive member about an axis through an arc in a first direction from a first angular orientation corresponding to the closed position of the door to a second angular orientation corresponding to the open position of the door and about the axis through an arc in an opposite direction from the second angular orientation to the first angular orientation, wherein rotation of the drive member from the first angular orientation to the second angular orientation corresponds to movement of the door from the closed position to the open position, and

a driven member including a protrusion formed on the surface of the driven member, one side of the protrusion forming a first driven surface and the other side of the protrusion forming a second driven surface, the driven member disposed for relative rotation adjacent to the drive member such that the respective protrusions rotate

in substantially the same plane and driven member protrusion moves in the free space defined by the driving surfaces of the drive member protrusion, the driven member adapted to be connected for rotation with the door closer assembly about an axis through an arc between a first angular orientation corresponding to the closed position of the door and a second angular orientation corresponding to the open position of the door and about the axis through an arc in an opposite direction from the second angular orientation to the first angular orientation, wherein rotation of the driven member from the second angular orientation to the first angular orientation corresponds to movement of the door from an open position to the closed position, wherein when the drive member and the driven member are in their respective first angular orientations, one of the driving surfaces of the protrusion of the drive member is adjacent to one of the driven surfaces of the protrusion of the driven member; rotating the drive member from the first angular orientation toward the second angular orientation in a direction toward the adjacent driven surface causing rotation of the driven member for powered opening of the door from the closed position to an open position; and rotating the drive member toward the first angular orientation of the drive member in a direction away from

the adjacent driven surface at a speed faster than the door closer assembly means rotates the driven member toward the first angular orientation of the driven member such that the protrusion moves in the free space without engaging the protrusion surfaces when the door is allowed to close.

[c25] 25. A door operating method as recited in claim 24, further comprising the step of terminating power to the motor when the door is the closed position.

[c26] 26. A door operating method as recited in claim 24, further comprising the step of stalling the motor for a predetermined period of time when the door is in an open position.